Innovative, satellite based method for water utility network leakage detection - Hungarian case studies

Tamás Madarász, Hoang Dinh Thien; Zsombor Fekete, Jonathan Jacobi

MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

Water WiseWays

SZÉCHENYI 2020

UTILIS

The issue of water leakages

- Non-Revenue Water is a major operational issue for water utilities
  - NRW includes: malicious water use, leakage and technology water
- Water leakage generally ranges between 8-30% in most utilities
  - Costs of treatment and pumping
  - Additional demage in infrastructure
- Leaks never get smaller!
  - Aging drinking water network
  - Finding the leak - The earlier the better
- Detection methods
  - DMAs
  - Field measurement techniques (Aquistic measurements, correlators)

UTILIS Ltd – Leaks can be detected from space!

- UTILIS is an Israeli start up company established in 2015,
- The company was established to **improve and market an intrusive technology that provides large scale leakage detection solutions** to utility companies
- Utils Ltd has filed **2 US patents** applications:
  - Filed on March 24, 2015 - US Patent No. 9,285,475.
  - Filed on February 3, 2016 - US Patent No. US 2016/0282463.
- UTILIS technology was awarded by several **prestigious innovation awards** during the last 2 years
  - Imagine H2O 2017; ACE16 of AWWA; Singapore International Water Week 2017; Aquatech innovation award Netherlands 2017; Fast company USA 2018; Water First 2018, Milan, Italy

MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

Water WiseWays

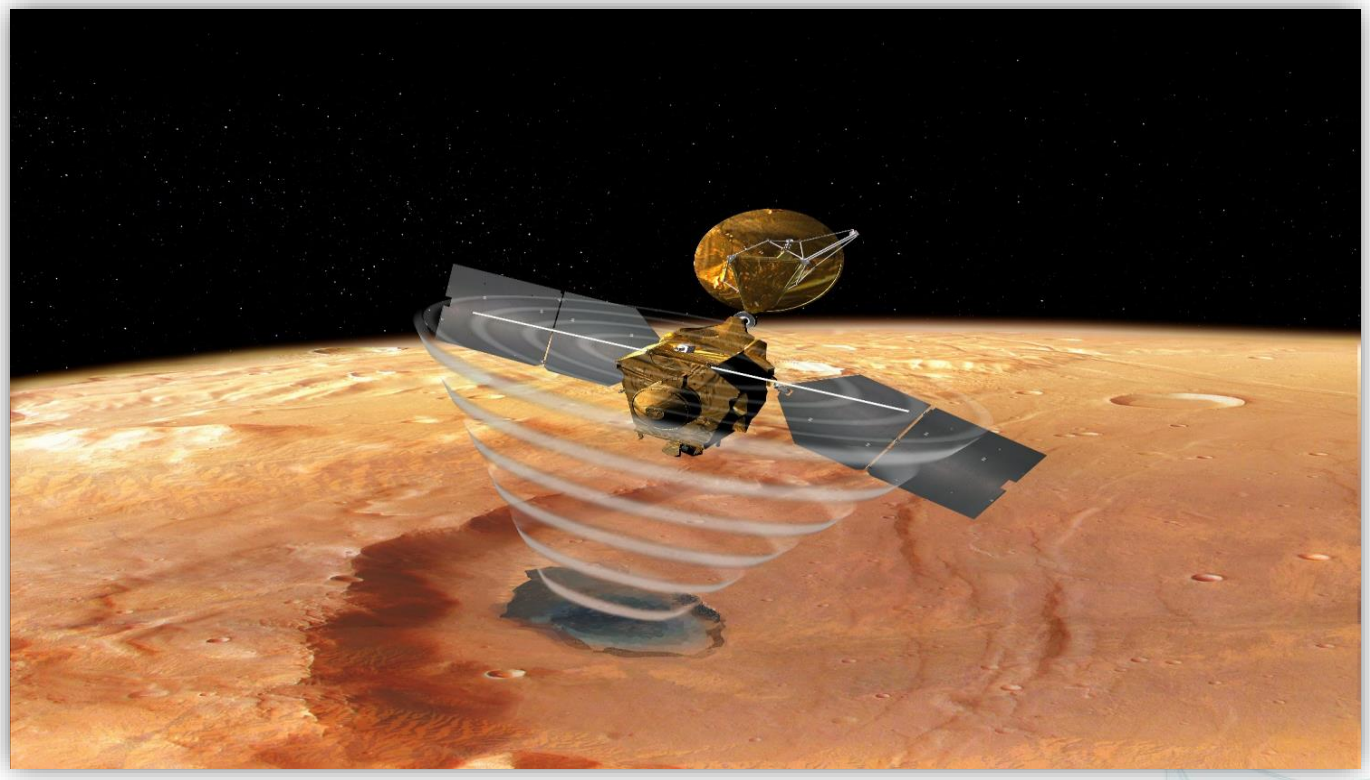
SZÉCHENYI 2020

UTILIS

Solution overview

For a long period of time **radar has been the prime candidate to look for submerge water in far planets**.

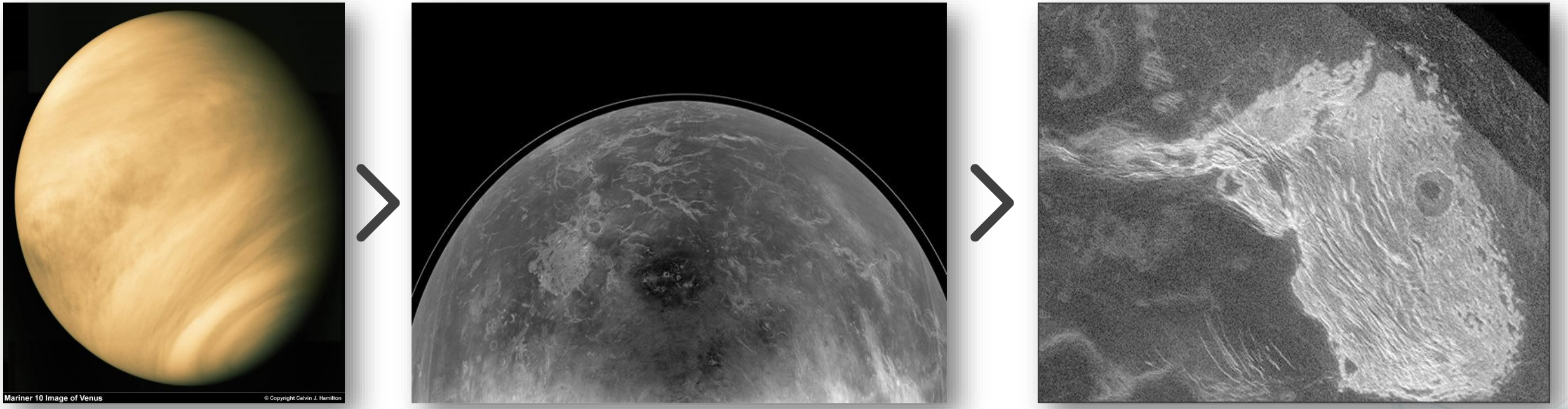
UTILIS offers a low-cost, high accuracy remote sensing technology for leak detection in urban supply systems. Using **spectral satellite imagery to monitor drinking water** in the ground, proprietary algorithms **identify leaks** in **user-friendly GIS reports** and **quantify the financial implications of non-revenue water loss.**



Slide with UTILIS contribution

Solution overview

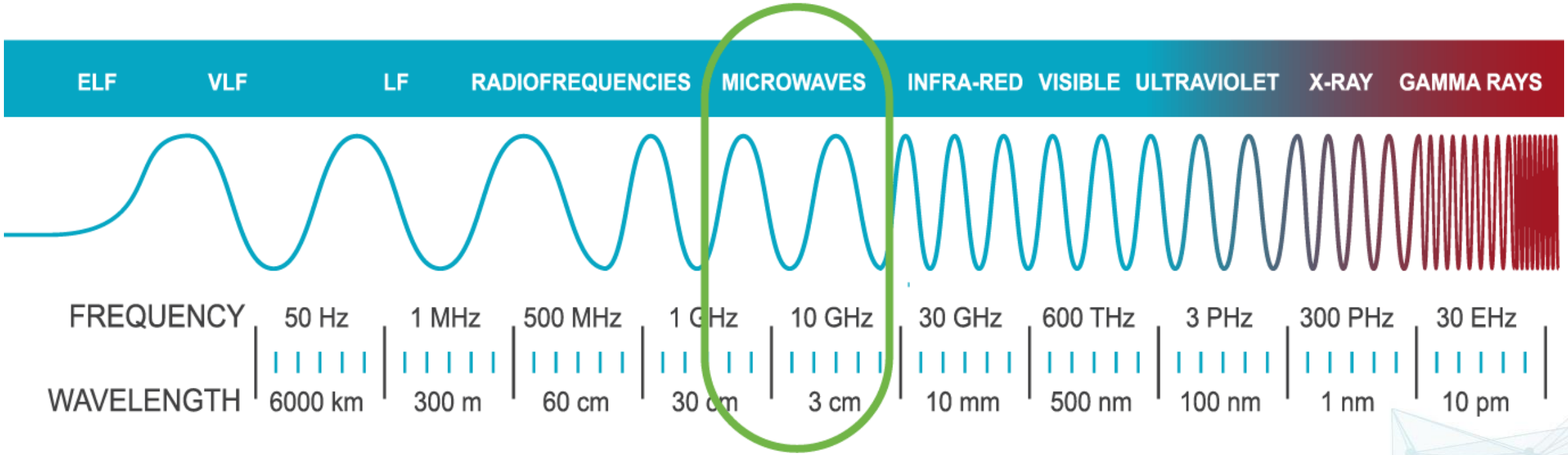
In order to see through the atmosphere - a long wavelength is needed.



Slide with UTILIS contribution

Solution overview

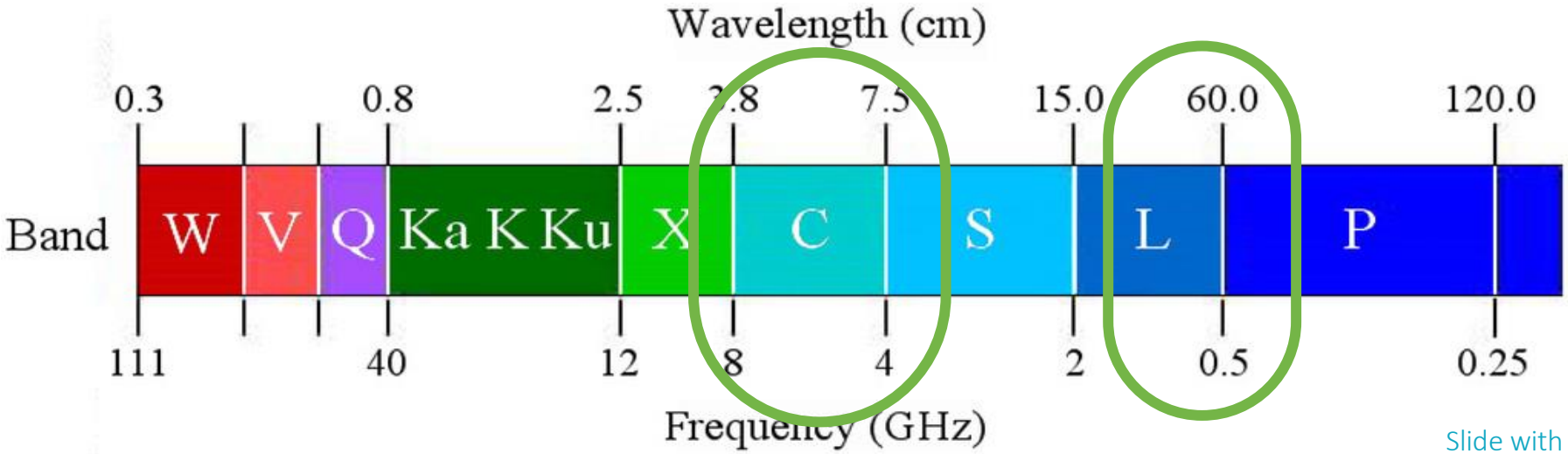
Radar can help us penetrate different materials in the atmosphere.



Slide with UTILIS contribution

Solution overview

- General **thumb rule** - You can penetrate up **to 3x-10x the wavelength**
- C band was initially used for atmospheric penetration
- In order to get deeper **L band was introduced, resulting 2-12m penetration** (depends on conditions)



Slide with UTILIS contribution

Solution overview

For **locating liquids radar was chosen** for another key reason as well

It’s high sensitivity to water = High dielectric constant

Dielectric Constant

$$\kappa = \frac{C_m}{C_0}$$

C_m: Capacitance with Material (Dielectric) in between the electric plates

C_0: Capacitance with Vacumm in between the electric plates

TABLE 1. TYPICAL RELATIVE DIELECTRIC CONSTANTS FOR SELECTED MATERIALS

Pure Water	81
Seawater	81
Seawater ice	6
Snow (firm)	1.4
Sand (dry)	5
Sand (saturated)	30
Clay (saturated)	10
Granite (dry)	5
Granite (w	7
Limesto	7
Limes	8
Shal	7
Sar	6
S	2-4
	0-25
	2-6
	5-20
	2-6
	0-20
P	5-13
Si	5-9
	10-15
Crac	4-5
	13-20
Asphalt	12-16

So different but the same value, That’s not good for us!

Slide with UTILIS contribution

Solution overview - the idea was born

Alos-2

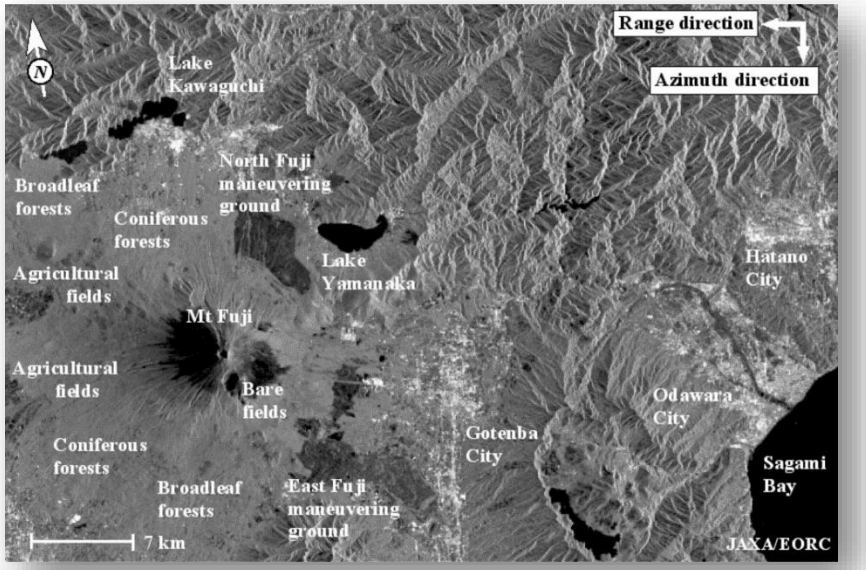
Advantages of remote sensing (L-band, 1.3 GHz)

- all weather capability
- day and night operation
- sensitivity to dielectric properties
- sensitivity to man made objects
- subsurface penetration

Slide with UTILIS contribution

Main challenges

- How can we differentiate between **various water types**?
- How can we work with **different soils** in high responsive times?
- How can we **eliminate the signal of rain water/snow**?
- How can we neglect different interferences like **buildings and man made objects**?
- How can we make sure that **shed zones from buildings** won't be a factor?
- How can we tell if a leak is **big/small/medium**?

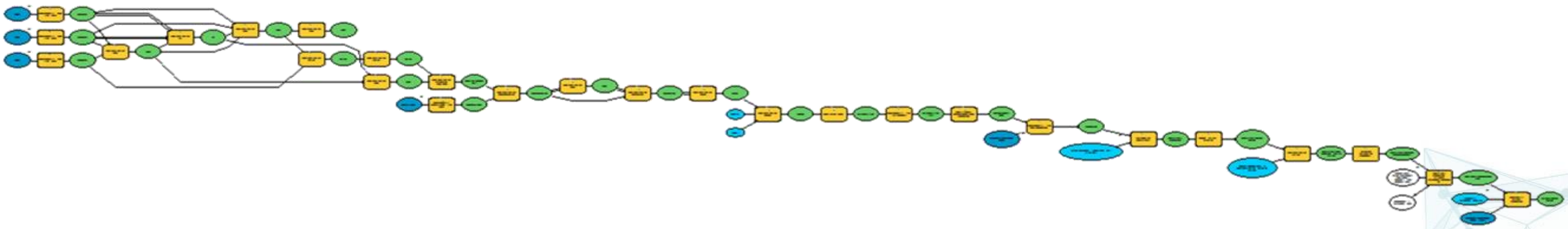


Slide with UTILIS contribution

The algorithm – for raw data interpretation

The process of breaking down the desires is starting:

1. Decide on an angle
2. Get the image
3. Clean the noise
4. Differentiate different kind of water sources
5. Emphasise the treated water



Slide with UTILIS contribution

The data interpretation process

1

Satellite Spectral Image Acquisition

Raw images of the area taken by a SAR operating in the L-band are acquired.

2

Radiometric Corrections

Utilis takes the raw data and prepares it for analysis, by filtering bounces from buildings and other manmade objects, vegetation hydrologic objects, and more.

3

Algorithmic Analysis

Using Utilis advanced algorithmic analysis to track the spectral "signature" of drinking water in the ground.

4

Web based app and intuitive UI

Leaks are displayed in user friendly GIS reports, within a less than 100 meters buffer .

Slide with UTILIS contribution

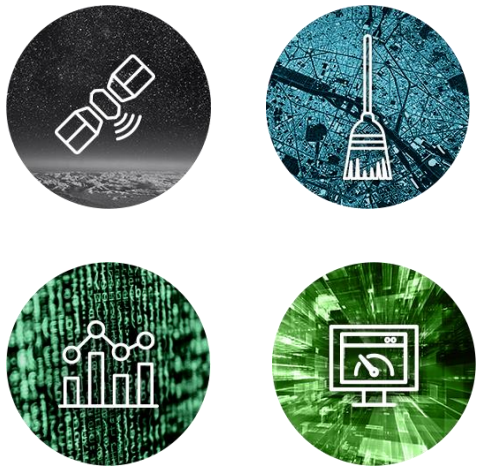
From Satellite image to water loss reduction

RADAR image

AOI (Area of Interest, polygon)

Pipes layer

algorithm analysis



Products

GIS files

Web application

Leak sheets

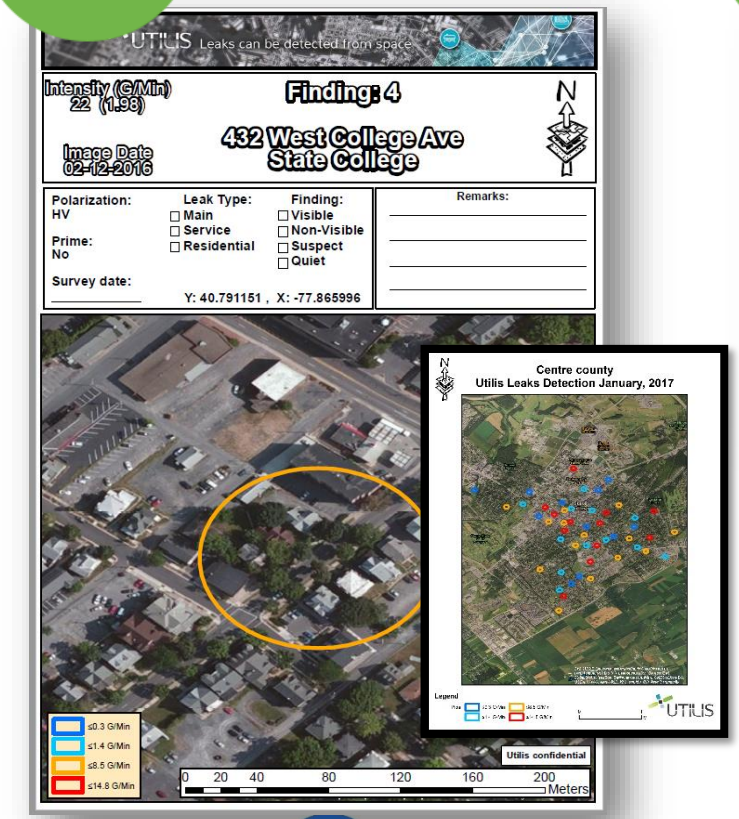
Data form

Slide with UTILIS contribution

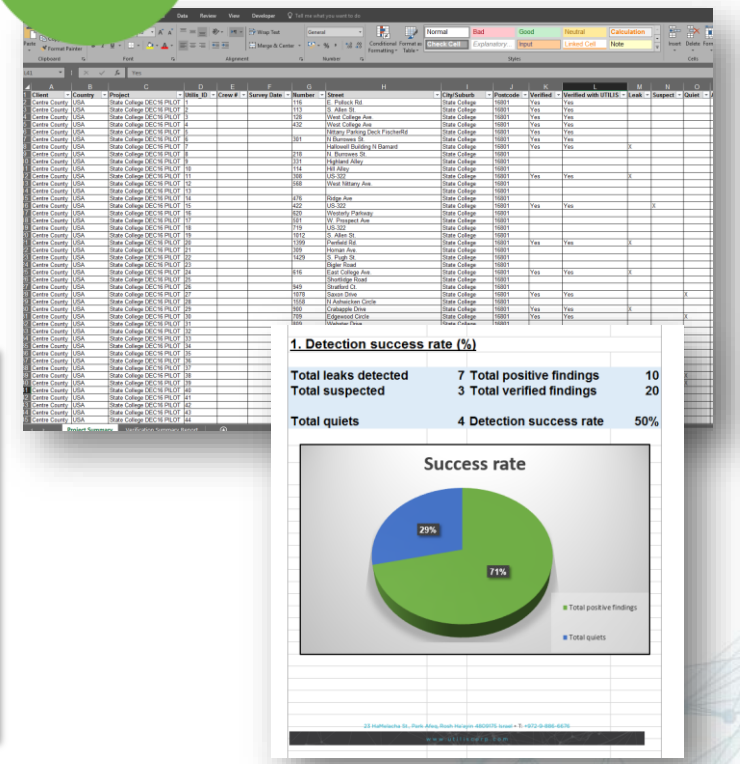
Deliverables for field varification

GIS files

Leak sheets

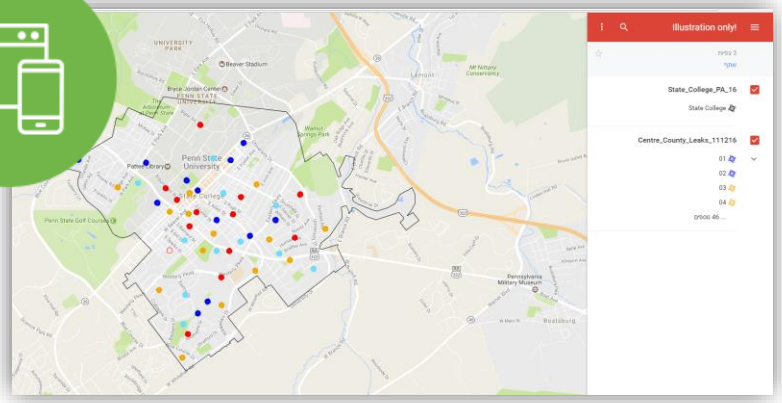


Data form



Slide with UTILIS contribution

Web application link



MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

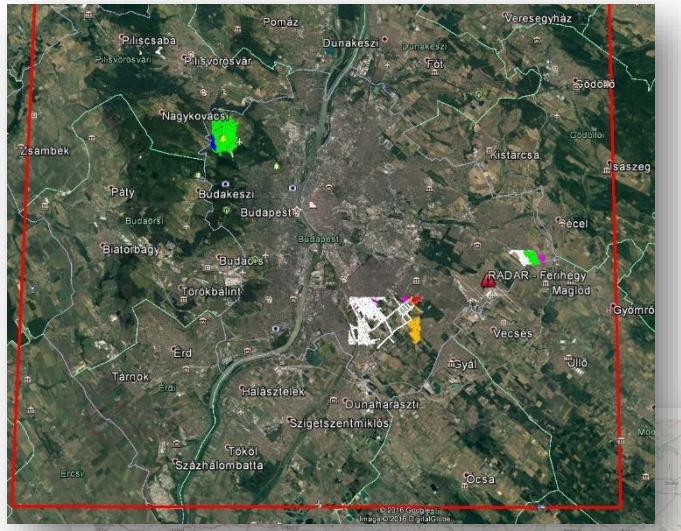
Water WiseWays

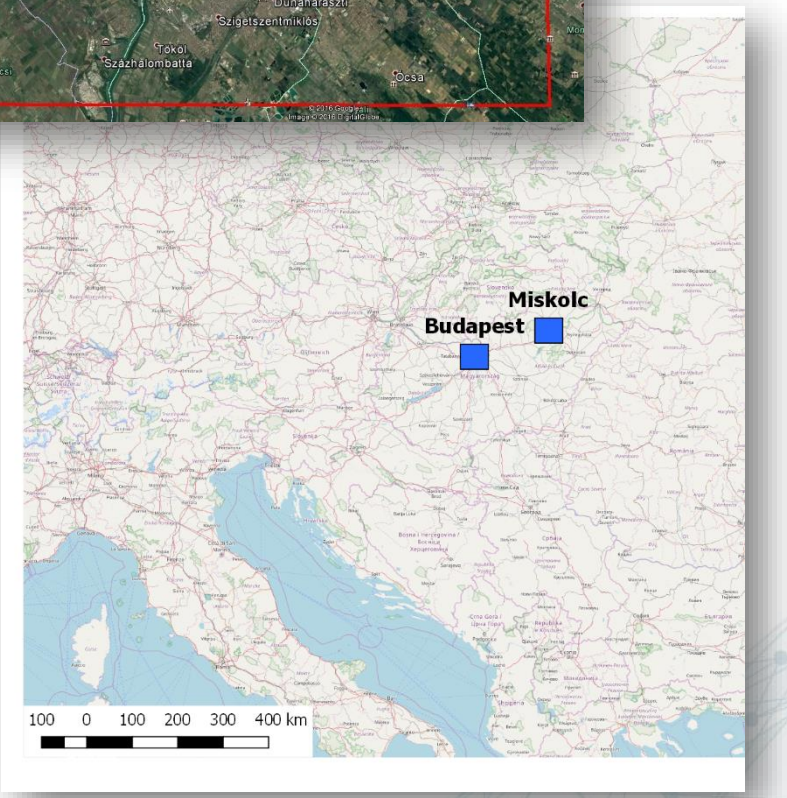
SZÉCHENYI 2020

UTILIS

The Hungarian pilots

- Joint research activtiy of UTILIS and University of Miskolc
  - Two pilots were selected: Miskolc and Budapest
  - AOI is identified for both pilots (March 2017)
- Dates and trajectory of **satelite image was selected** (April 2017)
- **Image acquired and analysis done** (May 2017)
- The problem of **sharing water pipe network** data!
- **Field varification** is done in June and September

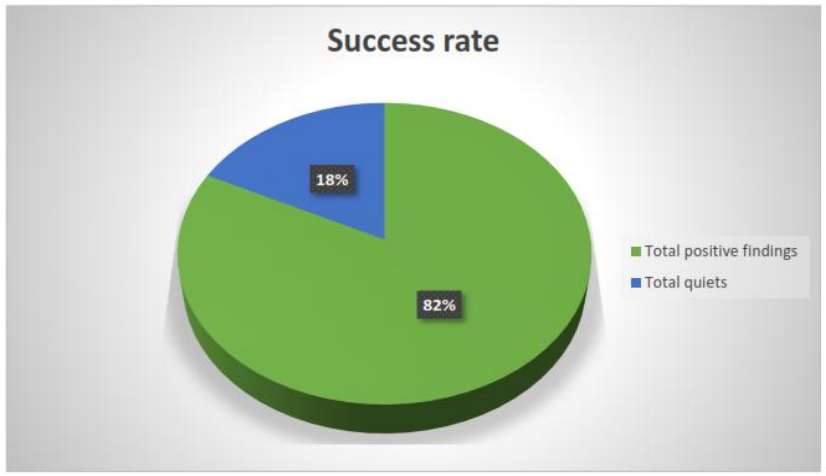


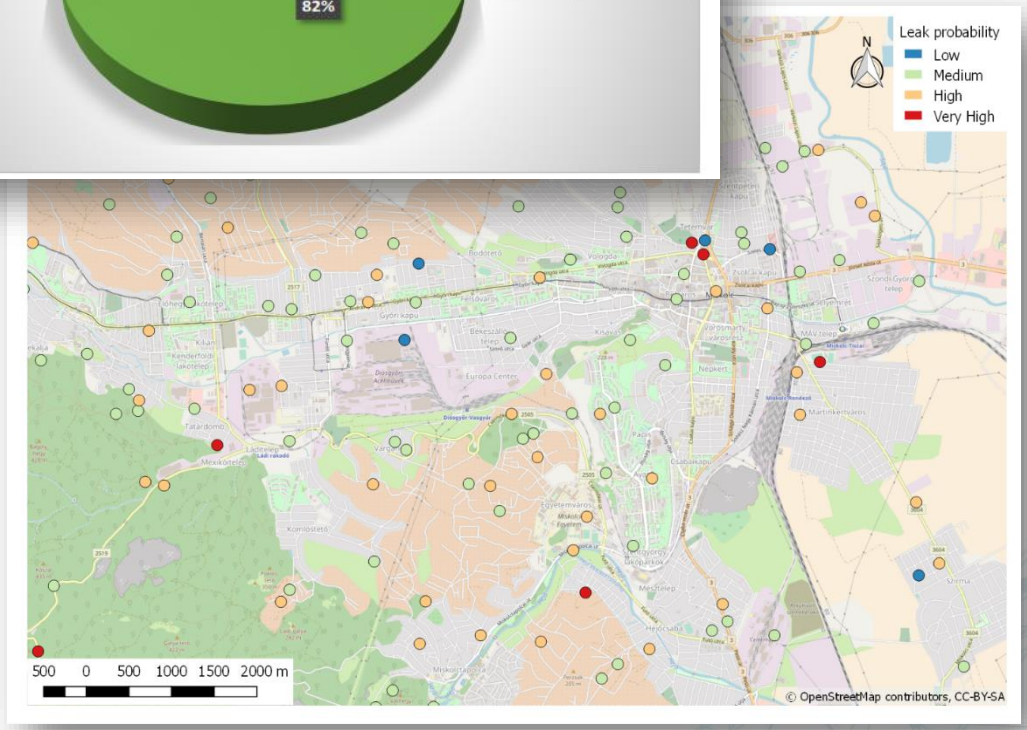


Field activities in Miskolc

- Satellite image taken: April 25, 2017
- Total number of **potential leaks: 235**
- Field validation dates: June 14-16
- Total suspected locations investigated/detected: 17/15
- Miskolc water utility
  - Total length of network: 470 km
  - 16,000,000m^3 pumped per year
- **30% water loss 4,800,000m^3**
- Capacity of suspected sites per day by acoustic team: appr. 7
- **0.6% of NRW in 2 days**
- Amount of work days needed per report: 15
- Estimated savings identified: 33,000m^3 (annual)

Total leaks detected	6	Total positive findings	14
Total suspected	8	Total verified findings	15
Total quiets	3	Detection success rate	93%





MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

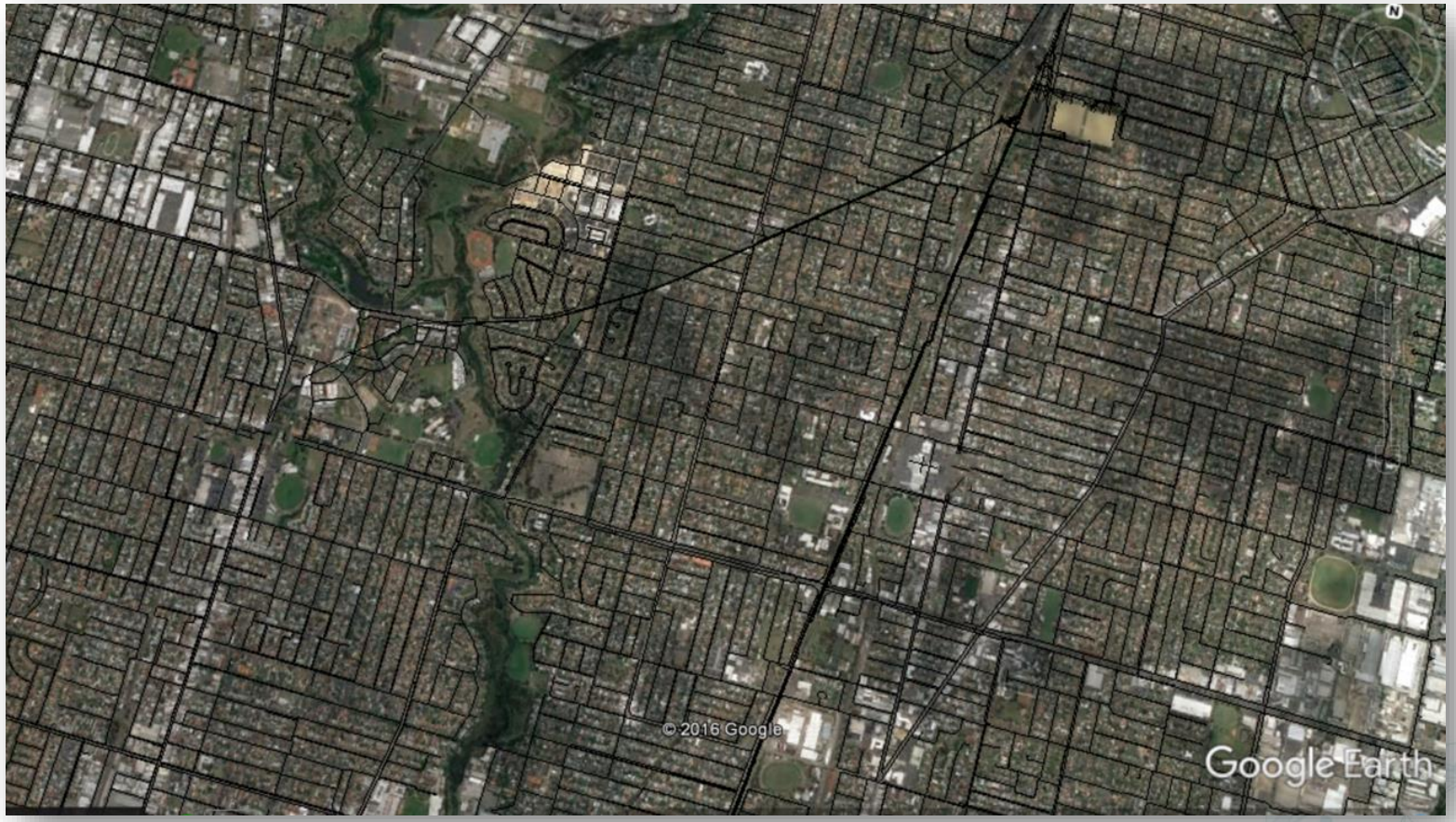
Water WiseWays

SZÉCHENYI 2020

UTILIS

Field validation - Standard Acoustic Survey

Without preliminary knowldge on leaks



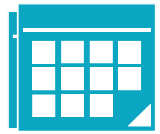
Slide with UTILIS contribution

Field validation - Standard Acoustic Survey

With preliminary knowldge on leaks!

Slide with UTILIS contribution

Efficiency of field varification

	Standard Acoustic Survey	Satellite Guided Acoustic Survey [Utilis + Traditional Acoustic]
Leaks Found per person / day	 <1.76 leaks/day/person	 >6.1 leaks/day/person
Leaks Found Per mile per man per day	 every 1.9 miles 1 leak Per person per day	 every 0.19 miles 1 leak per person per day
Survey Cycle length of time	 Every 1-4 years	 Quarterly Monthly, quarterly, yearly options

Slide with UTILIS contribution

Comparison between acoustic survey and satellite leak detection guidance was attained.

Field activities in Miskolc

MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

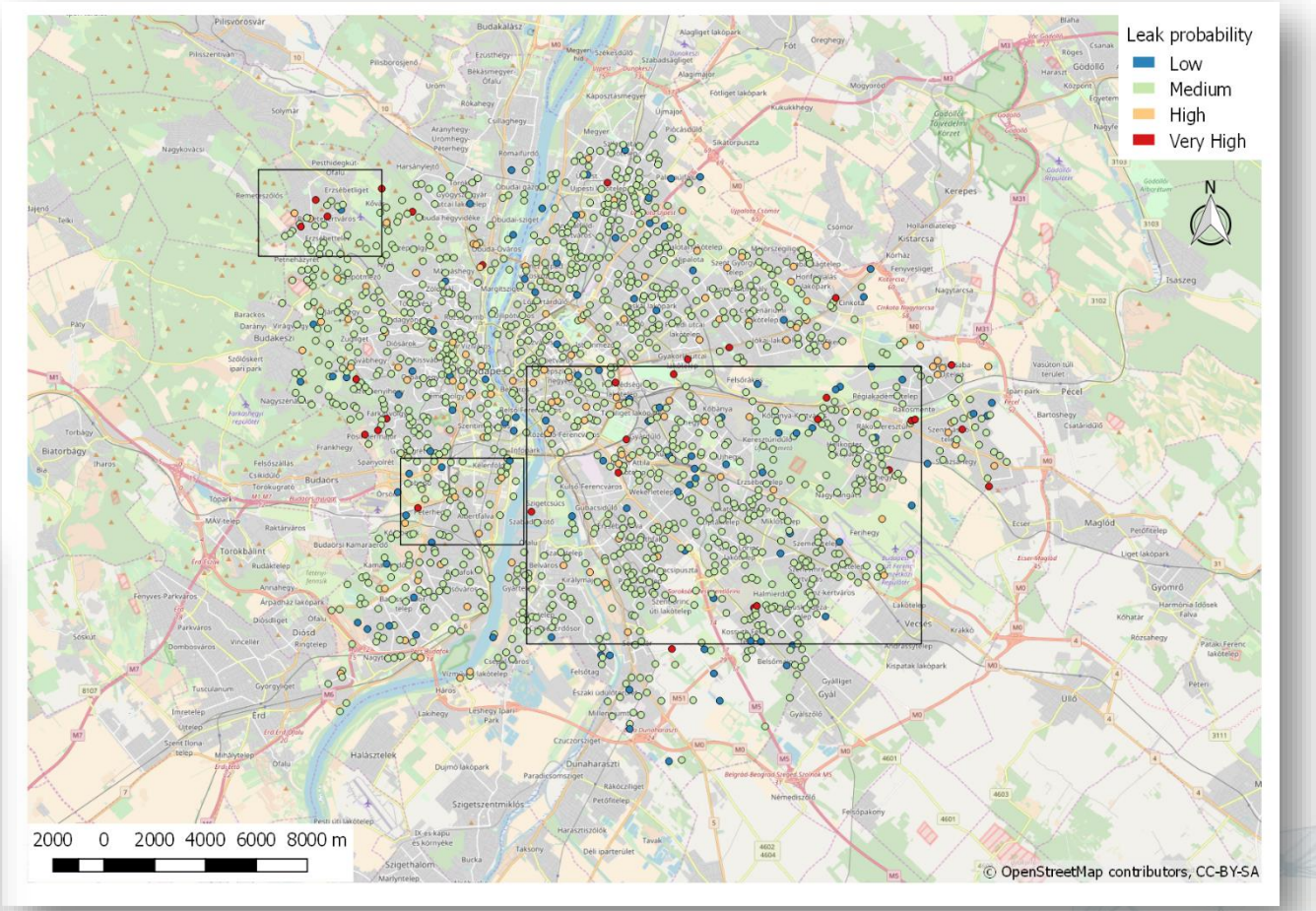
Water WiseWays

SZÉCHENYI 2020

UTILIS

Selected pilot 2 - Budapest, Hungary

- Image taken: May 6, 2017
- Total potential leaks found: 1407
- Two rounds of field validation: June 12-13rd and September 4-5th



MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

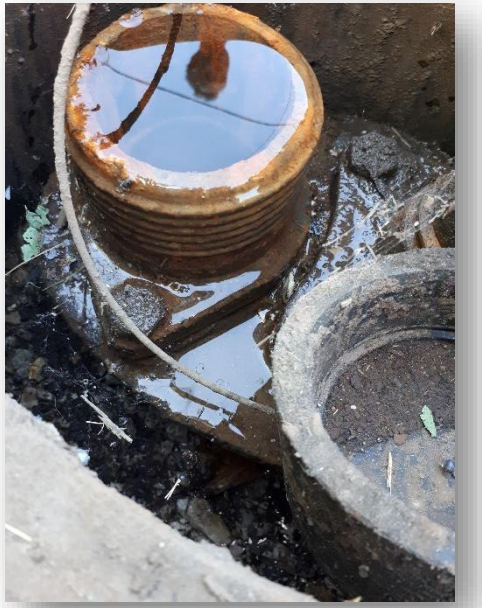
Water WiseWays

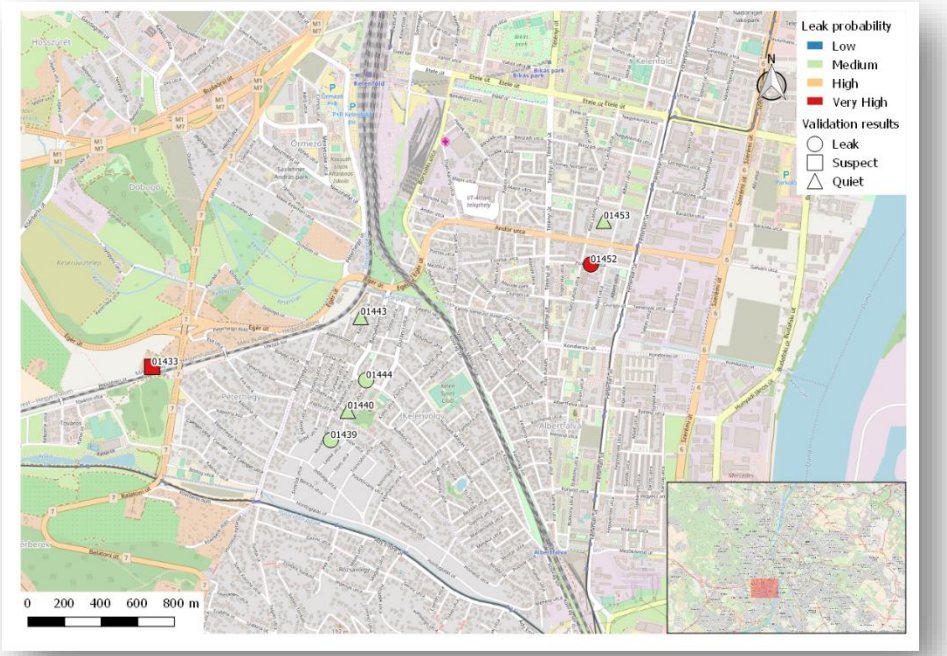
SZÉCHENYI 2020

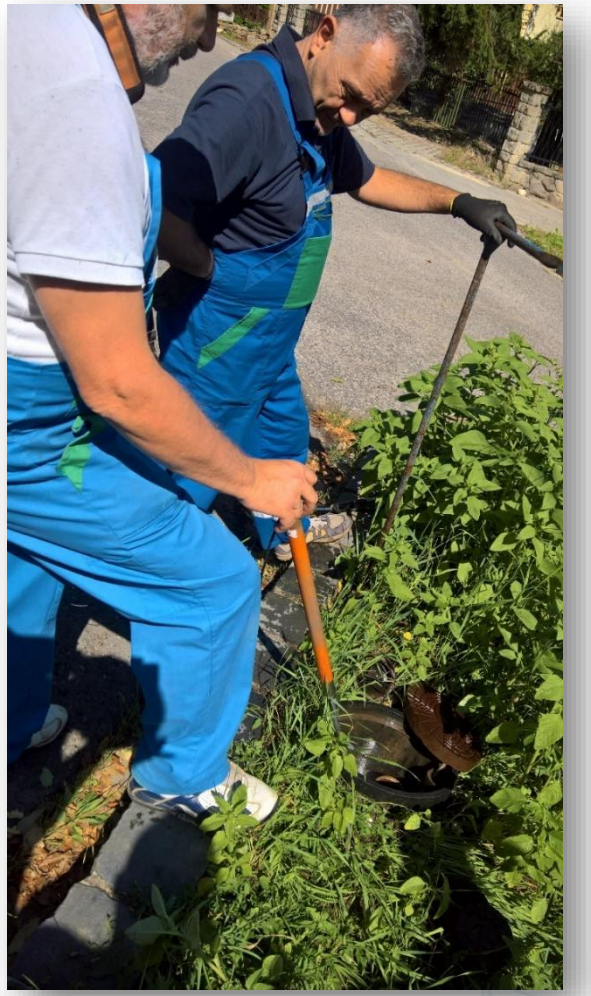
UTILIS

Field activities in Budapest

- 00311 – leaking valve of hydrant





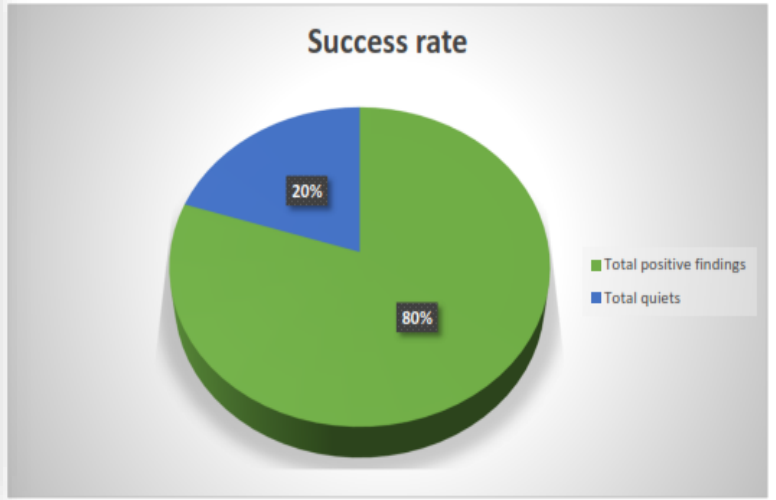


- 00323 leaking hydrant estimated 4,000 m^3 per annum

Field activities in Budapest

- Volume of annual water production: 162,802,000m3
- Volume of revenue water: 137,189,000m3
- NRW: 25,613,000m3 (annual report 2015)
- Physical loss (50% of NRW) = 12,000,000m (8%)

Total leaks detected	9	Total positive findings	12
Total suspected	3	Total verified findings	15
Total quiets	3	Detection success rate	80%



Conclusions of the Hungarian pilots

- UTILIS technology was **approved to be convincing** on both Hungarian test sites
  - The satellite based leak detection can **cost-effectively assist in reducing physical losses** on utility pipe network
  - Technology can work **even if the pipe network data could not be provided** to UTILIS Ltd
- During the few days of field work on both sites **remarkable results were achieved in reducing leakages** from the pipe network
- Miskolc water utility company **reorganized its acoustic leak detection program** and has been doing a systematic check on all potential leakage sites in the last two months
- Budapest waterworks is planning to **enter into full business contract** with UTILIS
- **University of Miskolc remains in partnership with UTILIS** working on further developments and technology innovation

MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

Water WiseWays

SZÉCHENYI 2020

UTILIS

Acknowledgement

The research was carried out within the GINOP-2.3.2-15-2016- 00031 “Innovative solutions for sustainable groundwater resource management” project of the Faculty of Earth Science and Engineering of the University of Miskolc in the framework of the Széchenyi 2020 Plan, funded by the European Union, co-financed by the European Structural and Investment Funds.

Thank you for your attention!